The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1968-59

Conference on Teleconnections in the Atmosphere and Oceans

17 - 20 November 2008

A regime view of the NAO and the effect of future climate change

WOOLLINGS Tim James
University of Reading Walker Institute for Climate System Research
Department of Meteorology Earley Gate, Whiteknights
P.O. Box 243
RG6 6BB Reading
UNITED KINGDOM

Department of Meteorology

The University of Reading

A Regime View of the North Atlantic Oscillation and Atlantic Jetstream Variability

Tim Woollings

with

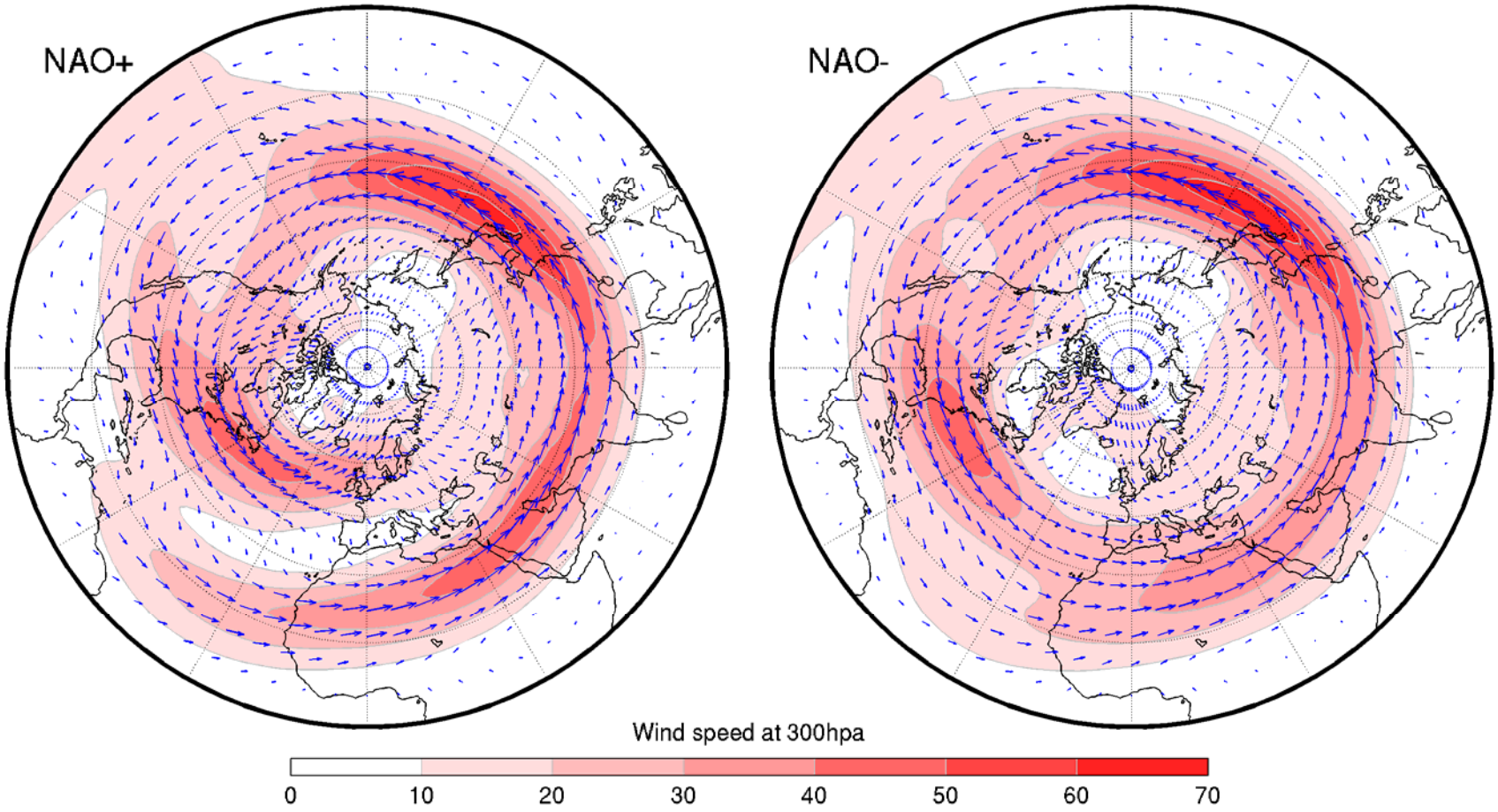
Brian Hoskins, Abdel Hannachi, Paul Berrisford, Mike Blackburn

NATURAL ENVIRONMENT RESEARCH COUNCIL

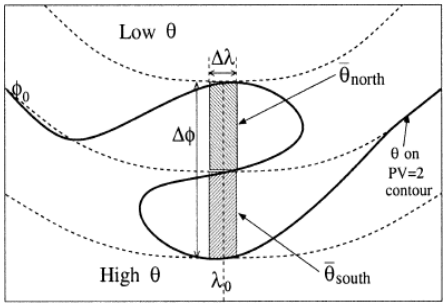
Walker INSTITUTE

The NAO describes variations in the latitude of the North Atlantic eddy-driven jet.

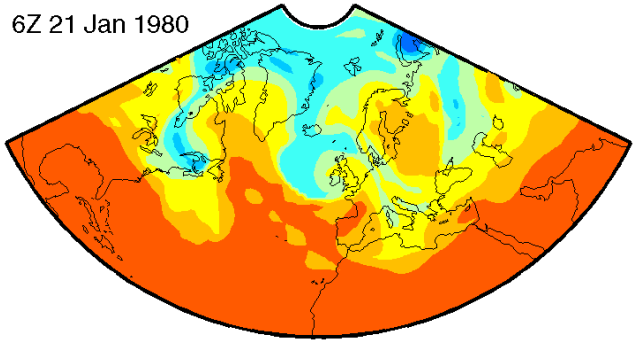
Lots of evidence that synoptic wave-breaking events drive these shifts.

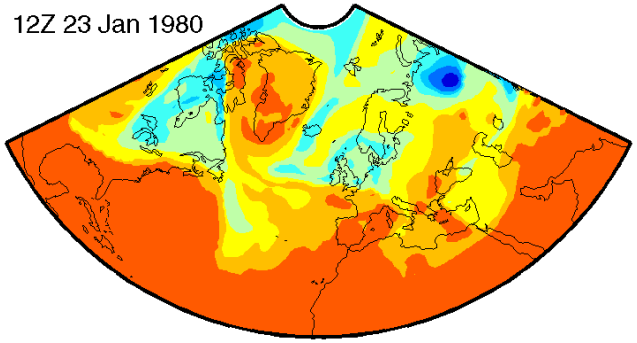


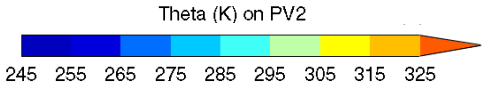
Greenland blocking = NAO-?



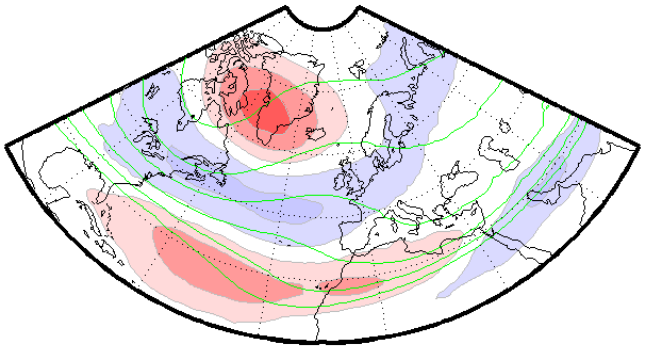
$B = \theta_{north} - \theta_{south}$

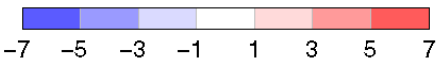




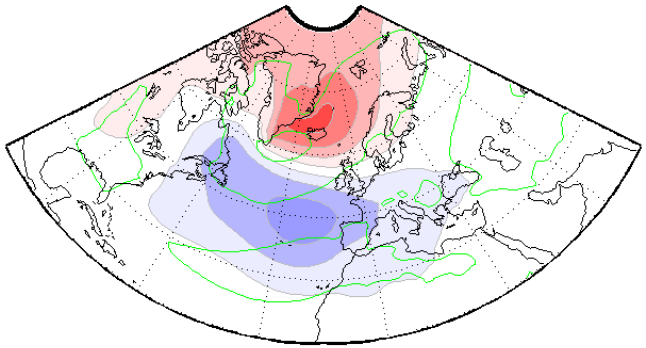


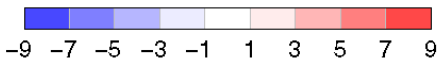
Theta on PV2





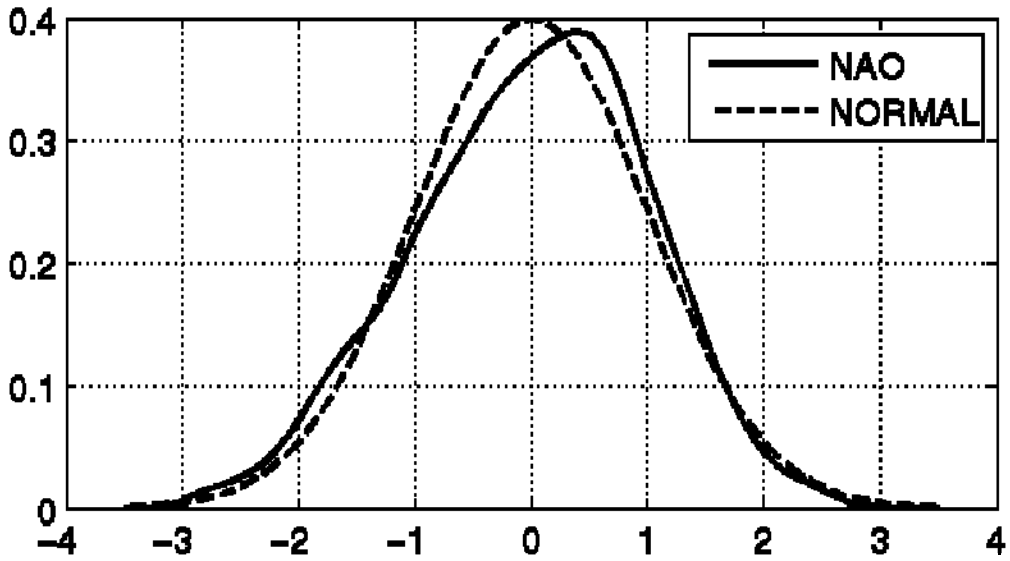
MSLP

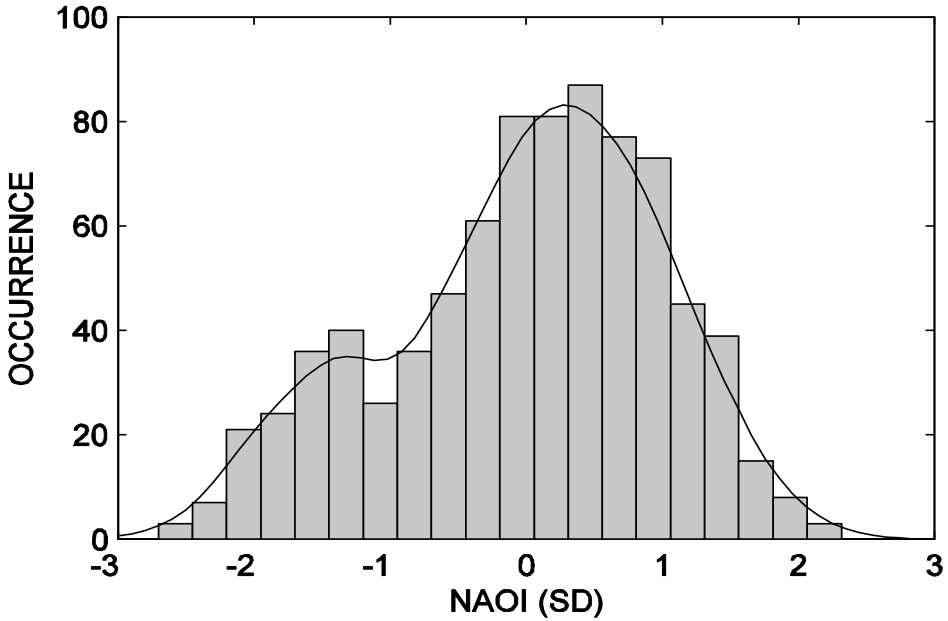




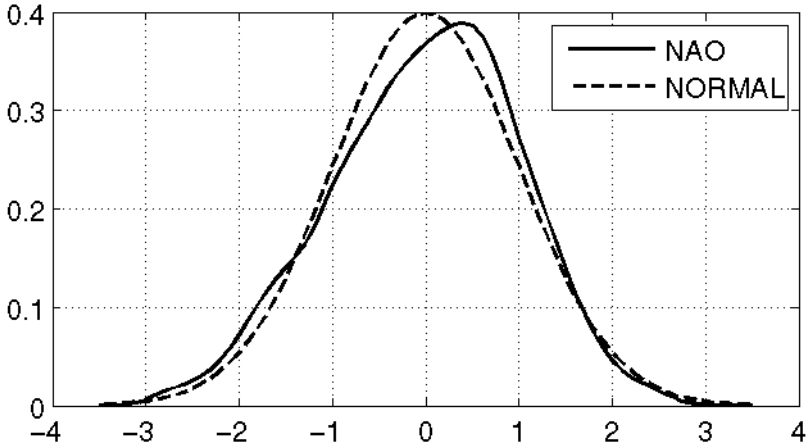
The PDF of the daily NAO index is significantly negatively skewed.

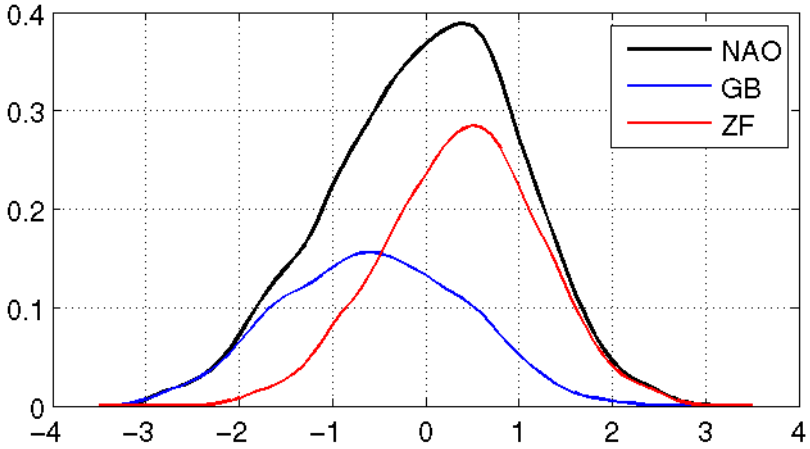
(Atlantic Z500 EOF1 projected onto daily anomalies.)



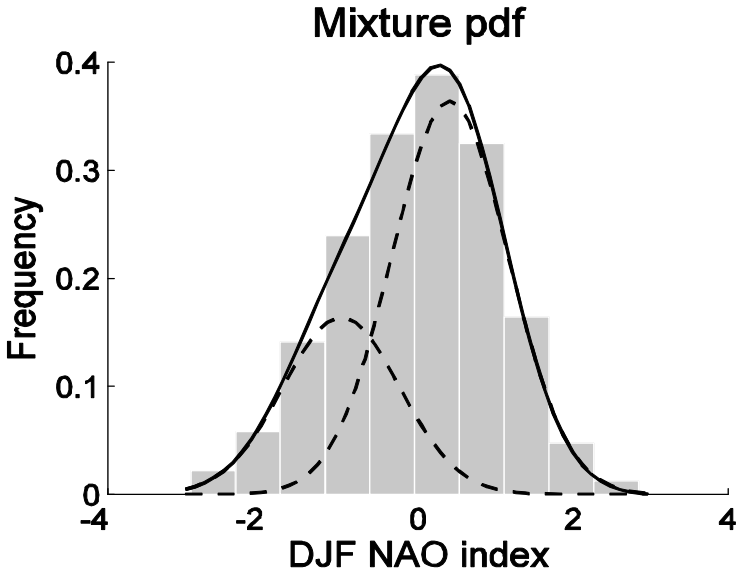


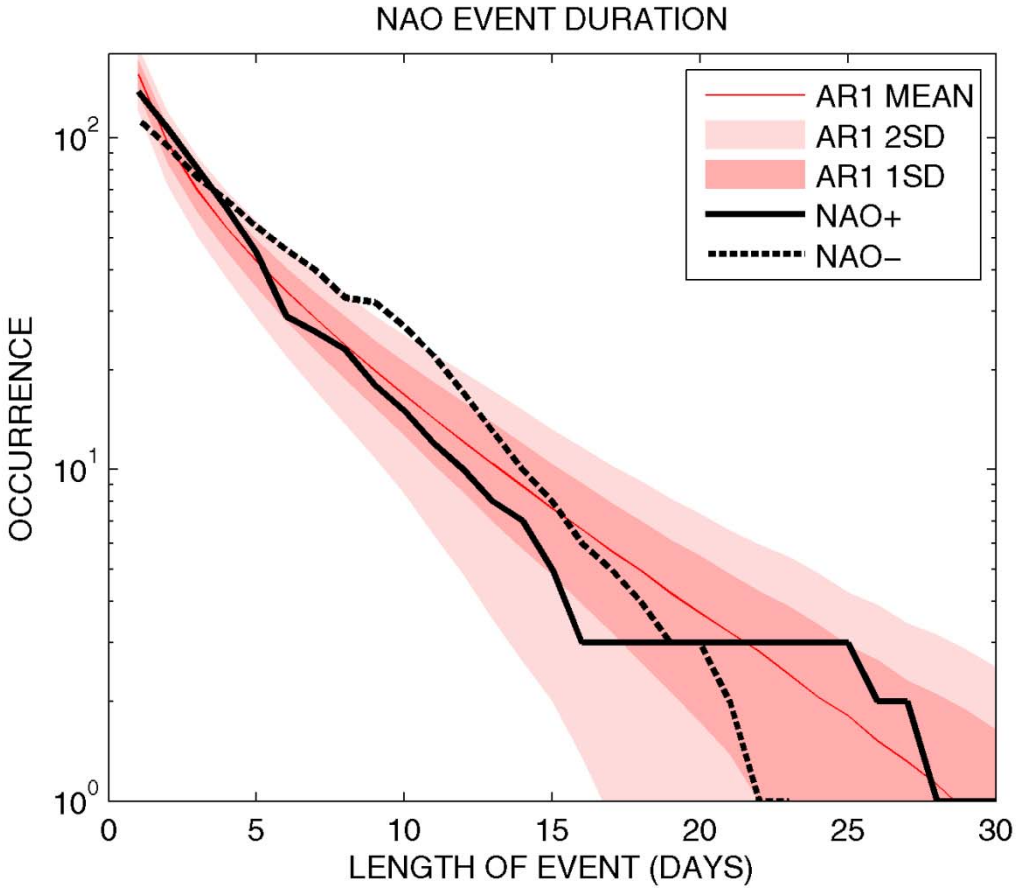
A pentad pseudo-station SLP index is very suggestive of regime behaviour.





Both the wave-breaking index and a statistical Mixture model suggest there are two distinct regimes of the NAO.

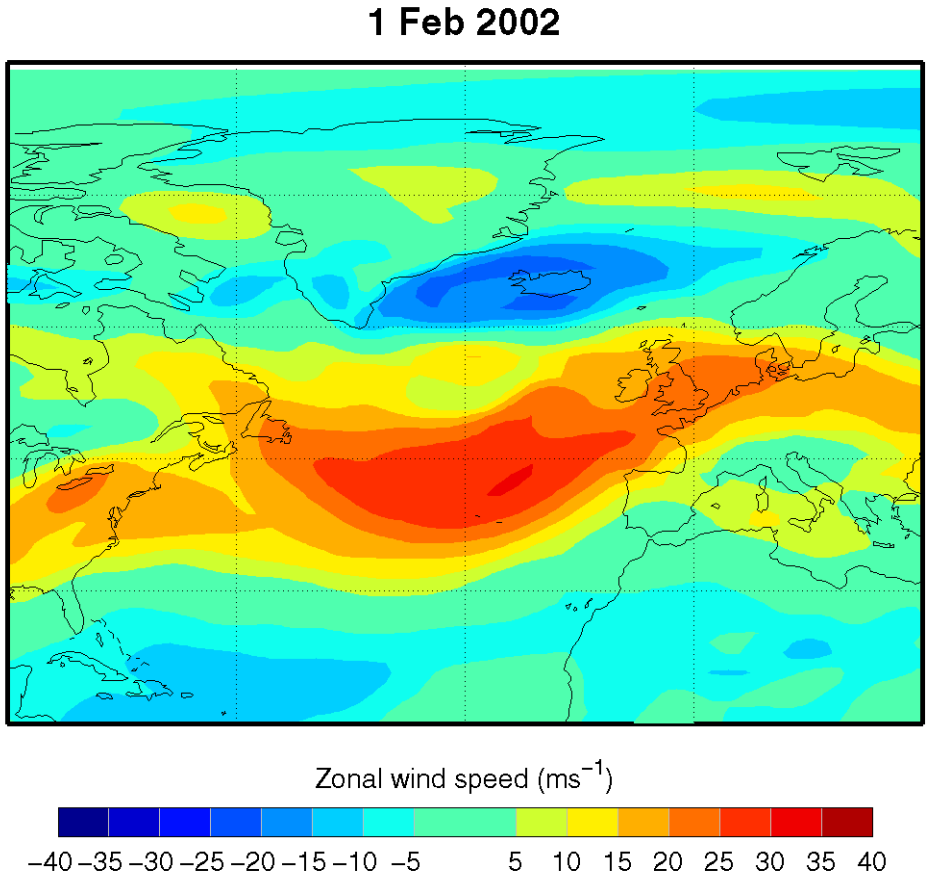


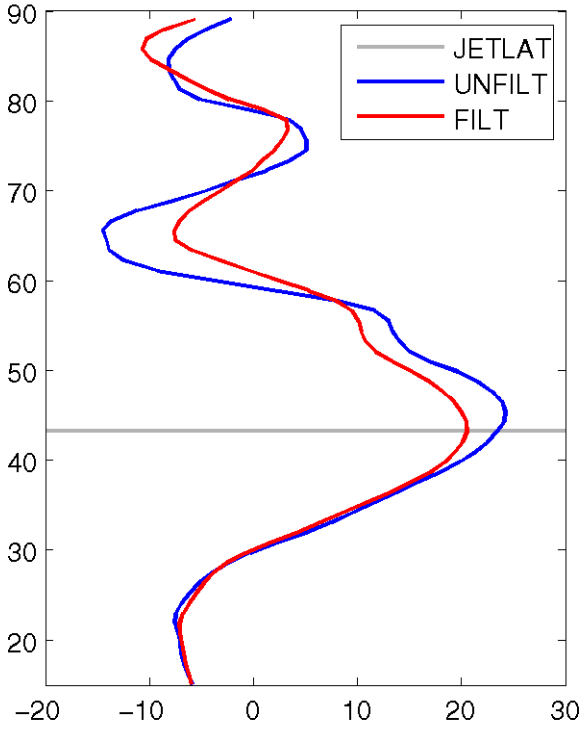


The decay timescale is different for positive and negative NAO events.

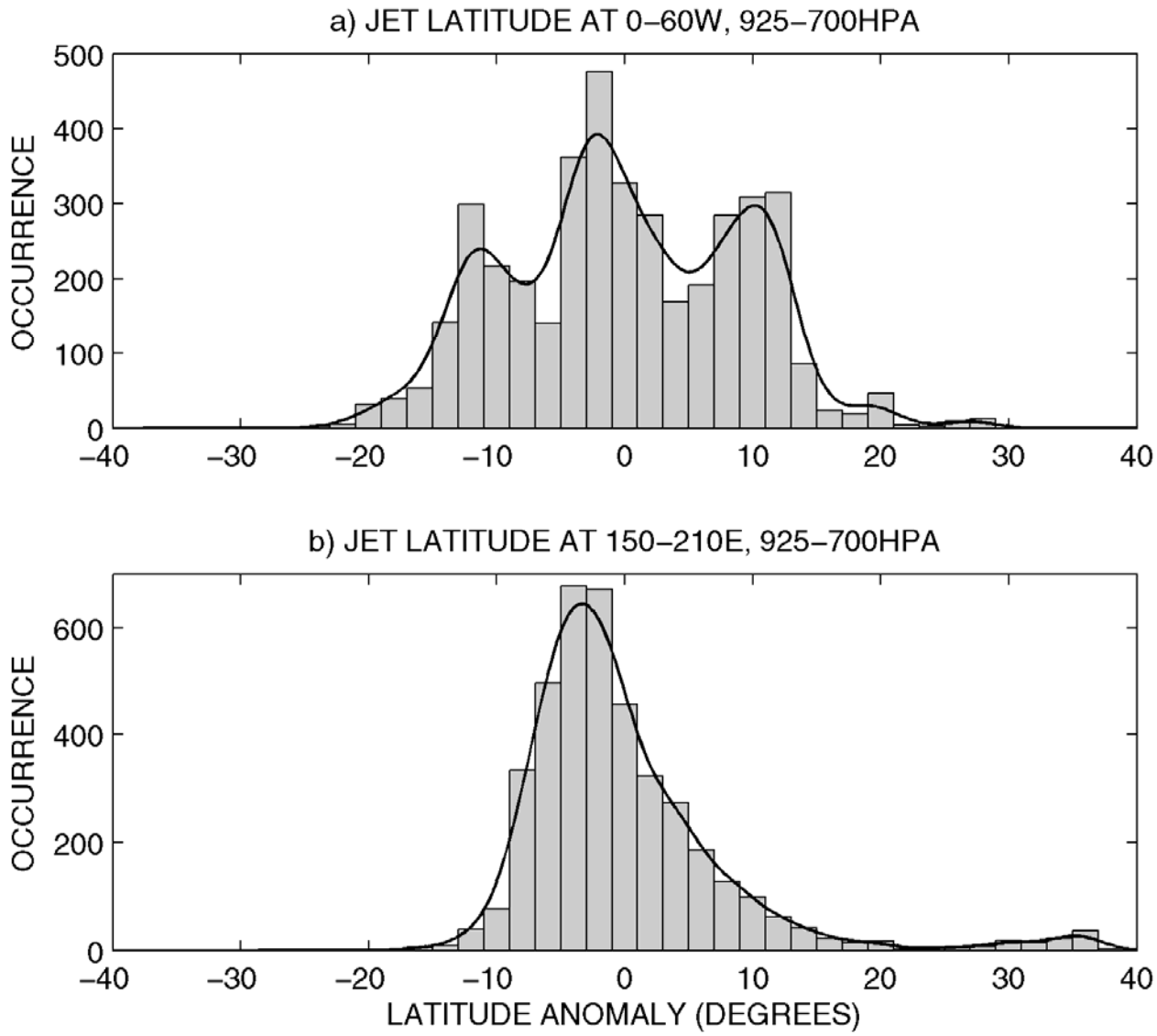
NAO- events are more persistent than a Markov model on the timescale 7-10 days, consistent with blocking.

Can we diagnose the latitude of the eddy-driven jet directly?



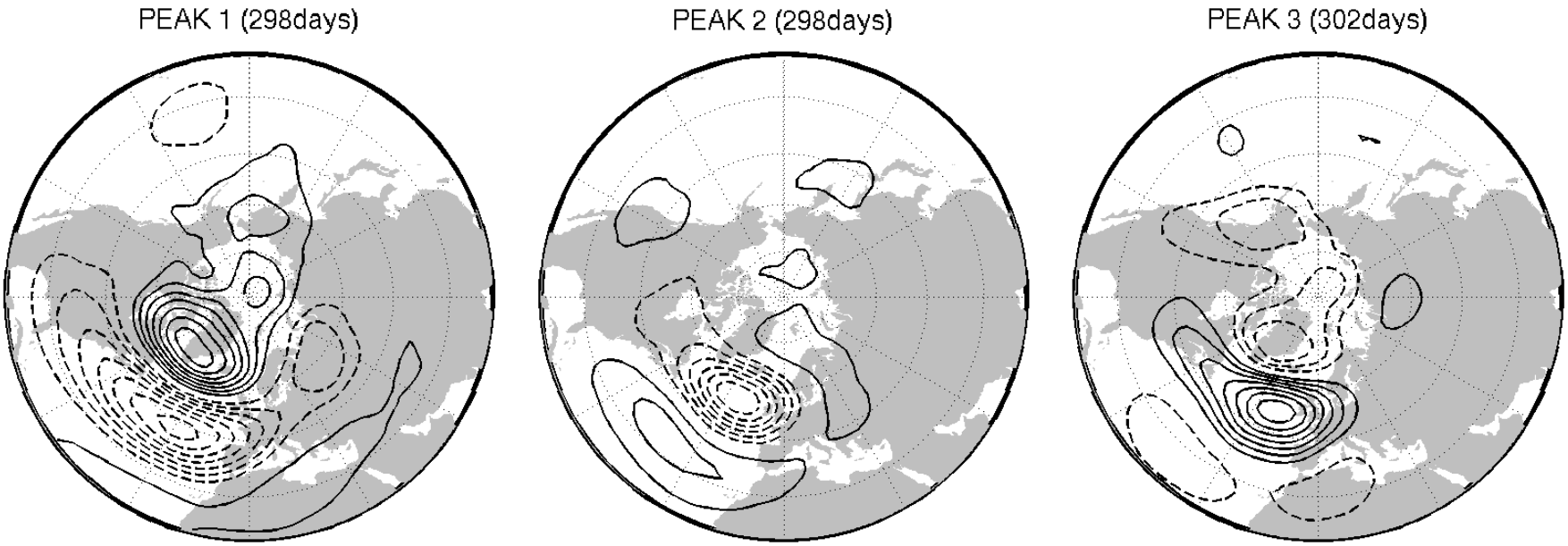


Method: Zonal wind -> Average over 0-60W and 925-700hPa
-> Low-pass filter (10 day) -> Find maximum
-> Remove seasonal cycle.

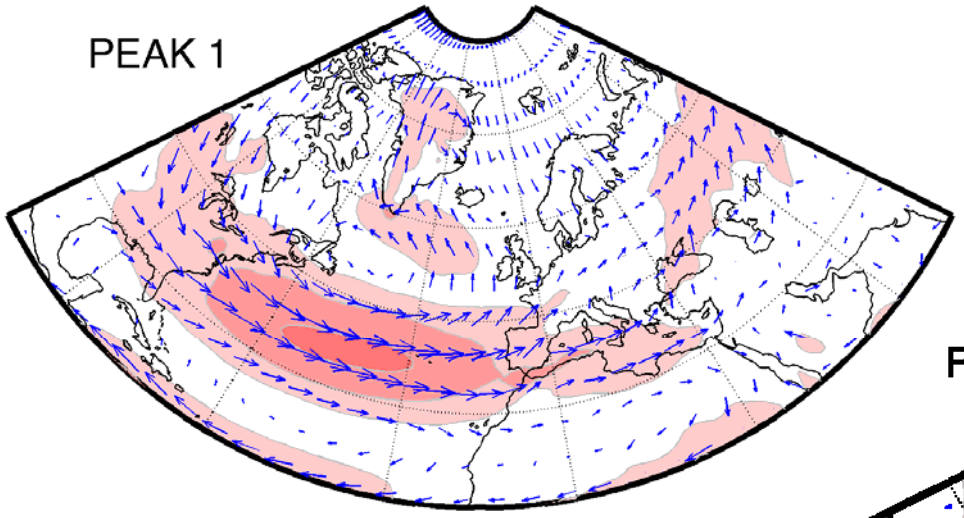


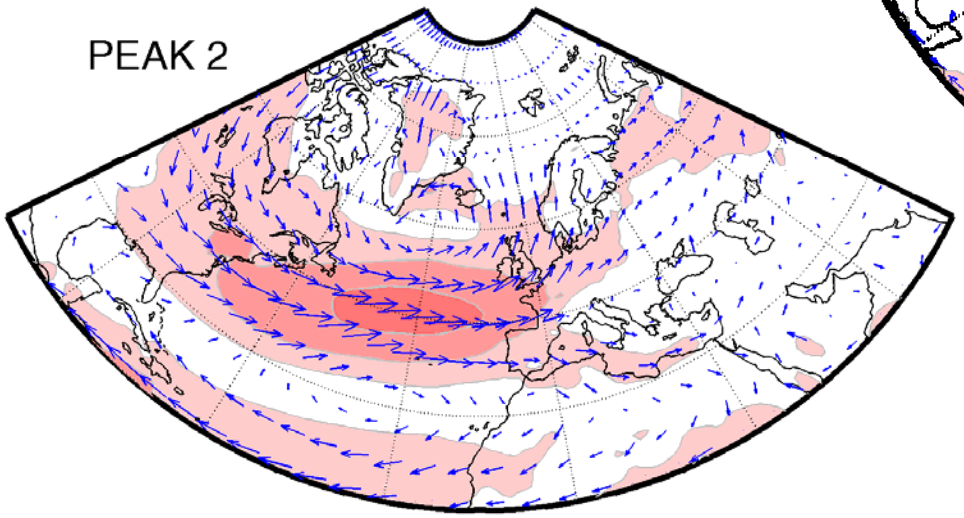
This suggests three regimes not two!

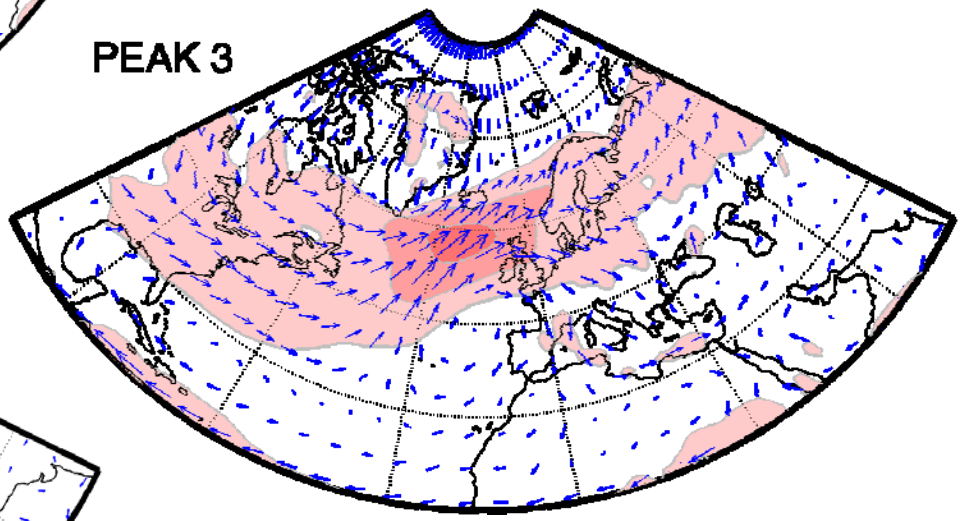
Quite robust to choices in the method, though some sensitivity to choice of longitudes.



The three regimes are associated with geopotential height patterns resembling NAO- and both phases of the East Atlantic pattern.

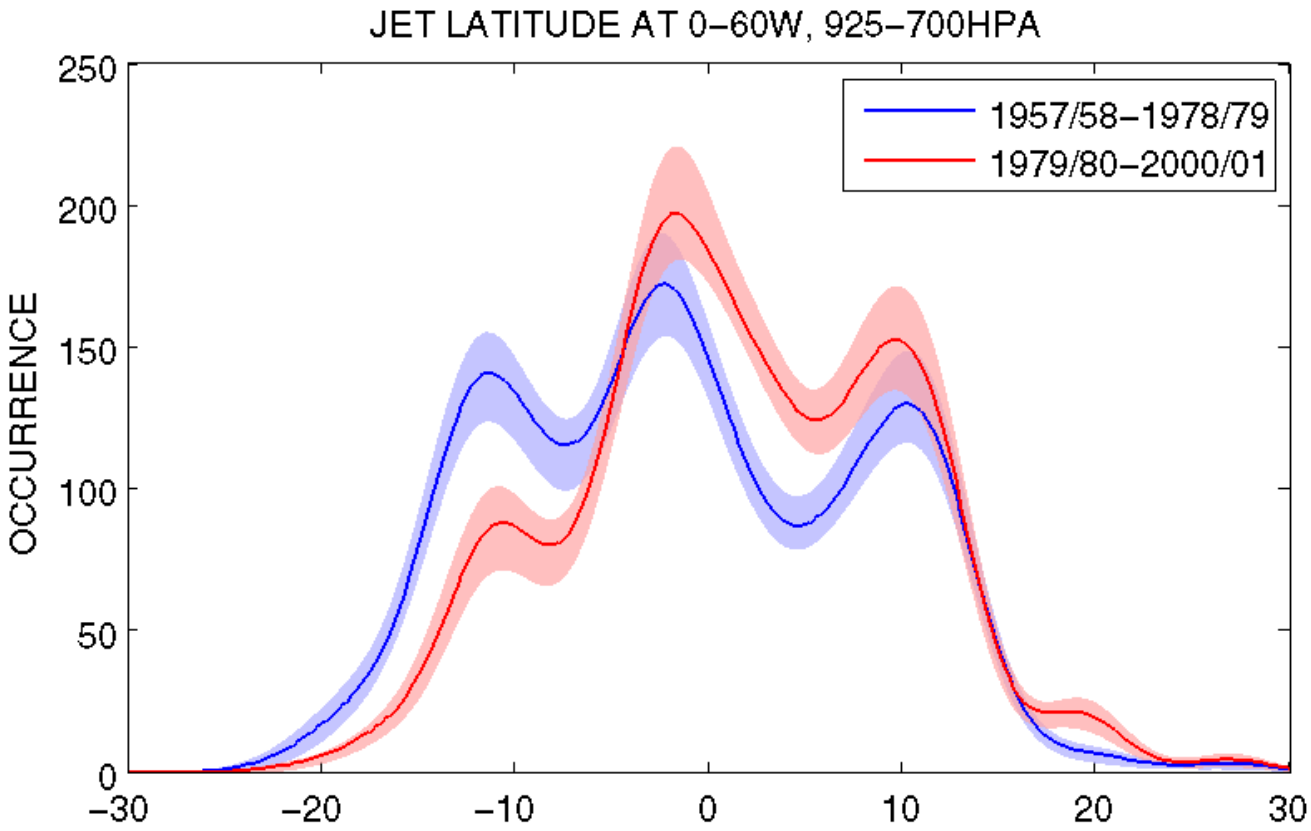


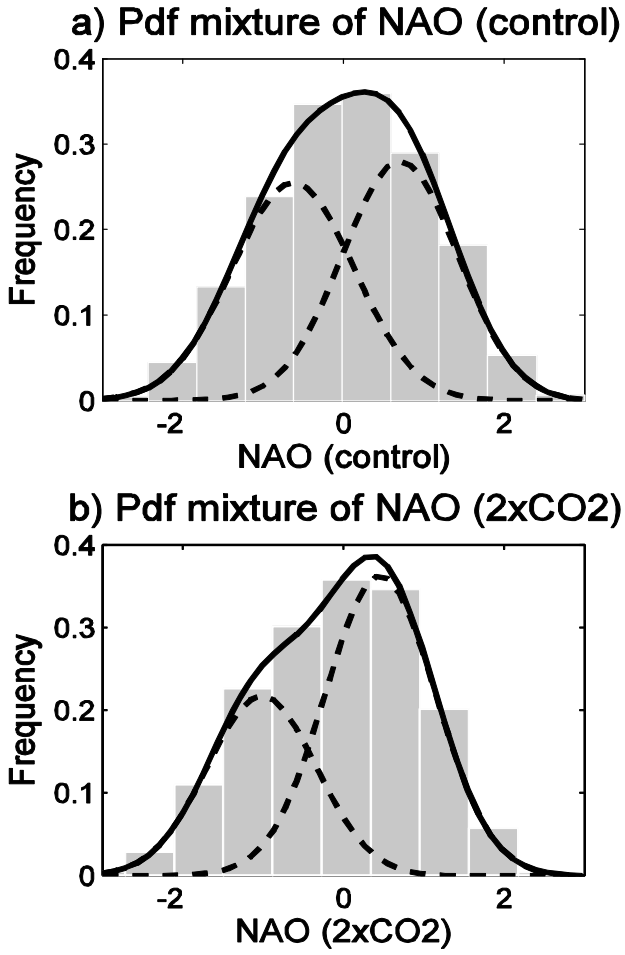


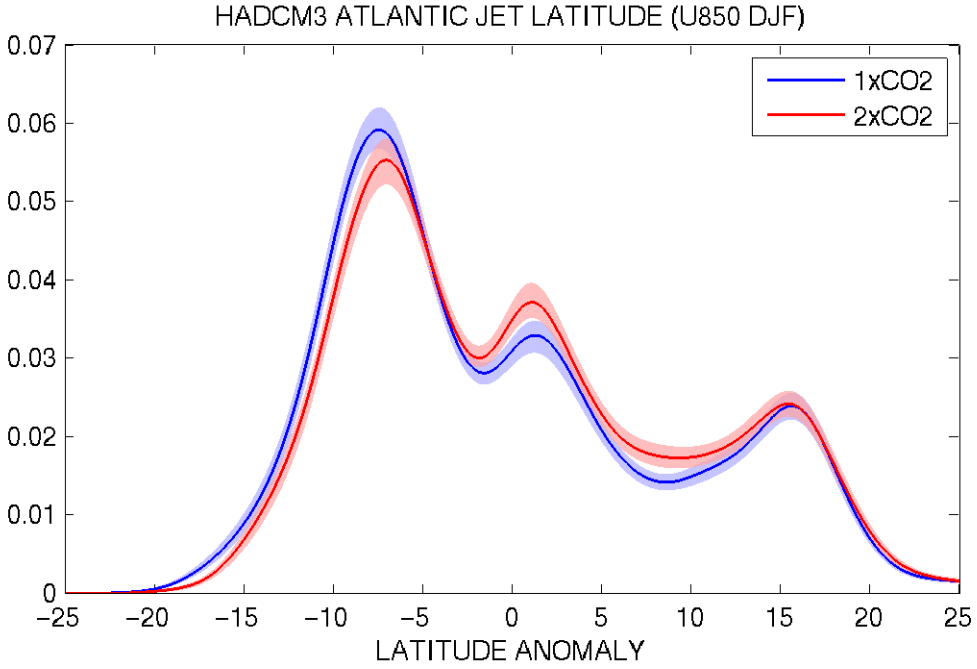


Composites of the full wind field at 850 hPa (contours 5 ms^{-1}).

Regime change seems to play a large part in the changes over the ERA-40 period



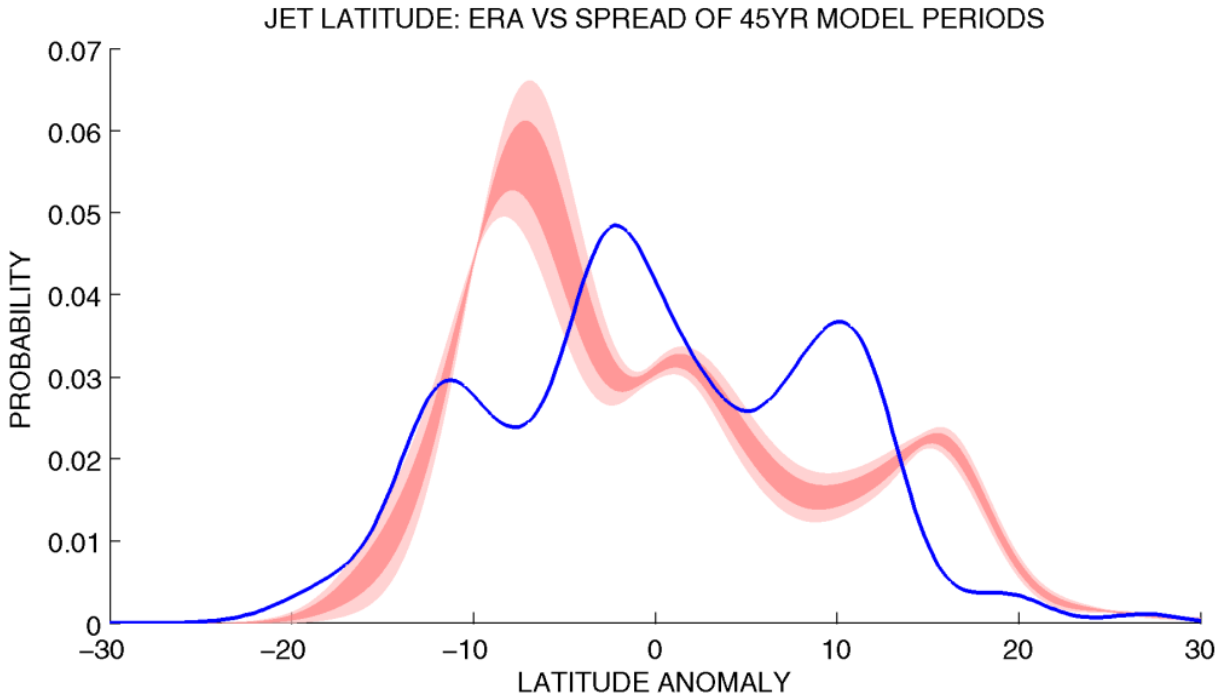




- HadCM3 has similar regimes but with very different loading.

- Both jet latitude and NAO analyses show that the model is too zonal, and changes relatively little with CO_2 forcing.

HadCM3 does not represent regimes realistically, which reduces confidence in its predictions of European climate change.



Summary

- The NAO index is significantly negatively skewed.

- This could be due to a distinct regime in negative NAO space corresponding to Greenland blocking.

- There seem to be three preferred locations of the Atlantic eddy-driven jet.

- HadCM3 does not represent regimes realistically, which reduces confidence in its predictions of European climate change.